

NON-PUBLIC?: N
ACCESSION #: 9112120065
LICENSEE EVENT REPORT (LER)

FACILITY NAME: Zion Unit 1 PAGE: 1 OF 05

DOCKET NUMBER: 05000295

TITLE: Reactor Trip and Safety Injection due to A.C. Instrument Inverter
Failure

EVENT DATE: 11/07/91 LER #: 91-016-00 REPORT DATE: 12/09/91

OTHER FACILITIES INVOLVED: DOCKET NO: 05000

OPERATING MODE: 1 POWER LEVEL: 100

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR
SECTION:

50.73(a)(2)(iv)

LICENSEE CONTACT FOR THIS LER:

NAME: Kenneth Dickerson, Regulatory TELEPHONE: (708) 746-2084
Assurance ext. 2371

COMPONENT FAILURE DESCRIPTION:

CAUSE: X SYSTEM: EF COMPONENT: INVT MANUFACTURER: W120

X MS RV M430

REPORTABLE NPRDS: Y

Y

SUPPLEMENTAL REPORT EXPECTED: NO

ABSTRACT:

At 0434 on November 7, 1991, with the Unit at 100% power and steady state conditions, A.C. Instrument Inverter 114 failed, causing the 'Low Steam Generator Level' and 'Low Steam Generator Pressure' bistables to trip. Six seconds later a Steam Flow/Feed Flow mismatch signal was generated due to 1C Feed Pump flow reduction causing a Reactor Trip. The reactor trip signal caused the High Steam Flow Program to reset as designed, resulting in a High Steam Flow signal. The High Steam Flow signal combined with the 'Low Steam Generator Pressure' bistables previously tripped to establish the coincidence necessary to actuate Safety Injection and Main Steamline Isolation.

The cause of the inverter failure was a component failure. A Silicon

Controlled Rectifier (SCR) in the Master section of Inverter 114 misgated causing a reduction in the inverter output voltage. This voltage reduction was sufficient enough to trip the channels of Reactor Protection and Safeguards instrumentation fed from this inverter.

During this event all safety related equipment operated as designed and there was minimal safety significance to this event.

Corrective actions included replacing all Unit 1 inverter SCRs prior to startup, including the SCRs in the preventative maintenance program and ensuring all Unit 2 SCRs will be replaced during the next Unit 2 refueling outage.

Previous events (LERS 1-91-005 and 1-91-008) documented A.C. Instrument Inverter failures that occurred on April 27 and May 10, 1991 on Inverters 111 and 112 respectively. The corrective actions from these LERs would not have prevented this event.

ZDVRLER-389(2)

END OF ABSTRACT

TEXT PAGE 2 OF 5

A. CONDITION PRIOR TO EVENT

MODE 1 - Reactor Critical RX Power 100%
RCS AB! Temperature/Pressure 558.6 degrees F/ 2254 psig

B. DESCRIPTION OF EVENT

On November 7, 1991, at 0434 hours, Unit One was at 100% Power and Steady State Conditions. No bistables were tripped, and no surveillances or other activities affecting reactor protection or safeguards were in progress.

At 0434:21, A.C. Instrument Inverter 114 failed, causing a loss of voltage to A.C. Instrument Bus 114. This caused 'Low Steam Generator Level' and 'Low Steam Generator Pressure' bistables to trip for the associated protective channels. Approximately six seconds later, a reactor trip occurred when a Steam Flow/Feed Flow mismatch signal was generated due to 1C Feed Pump flow reduction. The reactor trip signal caused the High Steam Flow Program to reset as designed, resulting in a High Steam Flow signal. The High Steam Flow signal combined with the 'Low Steam Generator Pressure' bistables previously tripped to establish the coincidence necessary

to actuate Safety Injection and Main Steamline Isolation.

The operators entered the Emergency Procedures and terminated the Safety Injection at 0438. During the transient all four Steam Generator atmospheric relief valves opened in response to the rapid rise in steam pressure (pressure increased from 700 psig to about 940 psig at a rate of about 125-150 psig/min.). As the rate of pressure increase leveled off, all but the 1D Steam Generator relief valve reseated. The operators responded quickly by manually isolating the valve.

Operator response was reviewed and determined to be appropriate throughout the event.

C. APPARENT CAUSE OF EVENT

The cause of this event was a component failure. A Silicon Controlled Rectifier (SCR) misgated causing a shutdown of the Master section of A.C. Instrument Inverter 114. This shutdown decreased the capacity of the inverter by approximately 60%. With this capacity reduction, the inverter was not capable of continuously supplying its normal load of approximately 33 amps. When the inverter output voltage dropped to approximately 45 volts, the Reactor Protection Process instrumentation for channel 4 tripped their respective bistables.

Under normal circumstances, loss of a single A.C. Instrument Bus will not cause a reactor trip. In this instance however, the voltage output of the inverter was lost in an erratic fashion, rather than as a total and immediate failure. The Feed Pump Lovejoy controller has a Track and Hold feature designed to 'hold' the pump at the last 'tracked' signal in the event of a loss of signal to the controller. During this event, the signal to the 1C Feed Pump controller was lost in an erratic manner with the failure of inverter 114. The controller was therefore unable to lock onto a signal and the 1C Feed Pump flow was reduced to 0%. When feed flow had reduced sufficiently, the loop C 'Steam Flow greater than Feed Flow' bistable tripped. This bistable, in coincidence with the, 'Low Steam Generator Level' bistable tripped by the inverter failure, resulted in the reactor trip.

ZDVRLE-389(3)

TEXT PAGE 3 OF 5

C. APPARENT CAUSE OF EVENT (continued)

Approximately 0.100 seconds after the reactor trip, loops A, C, D and B High Steam Flow bistables corresponding to channels 513, 523, 533, and 543 were tripped. These are expected post trip signals since the Steam Flow program value is reset to 40% by a reactor trip

signal while actual Steam Flow is still close to 100%. With the 'Low Steam Pressure' channel 516 and 546 signals already received when Inverter 114 was lost, the coincidence for Safety Injection was established.

The SCR misgate is suspected to have been caused by the combination of 3 factors:

1. SCRs manufactured prior to 1975 are believed to be constructed using a soldered or brazed gate junction. This type of construction is thermally sensitive and the resulting gate voltage decreases as a function of increasing SCR temperature. This temperature correlation is particularly pronounced at temperatures greater than 50 degrees Celsius.
2. The thermal contact grease, which was used in older installations has a tendency to degrade after approximately 5 years. This significantly decreases the heat transfer coefficient between the component and its heat sink.
3. The SCR gating signal is known to normally contain electronic noise, principally because of its proximity to high power components. This gate noise is considered to be statistically random and can be a significant percentage of the total gate signal amplitude.

Putting these factors together it is postulated that the older style SCRs became more sensitive to low gating voltages as the thermal contact grease degraded over time. Eventually, one of the master section SCRs reached a high enough operating temperature to be gated on a noise pulse rather than one of its normal gate signals. This misgating was out of the normal gating sequence, causing abnormally high output currents and ultimately blowing the output fuses.

Disassembly and inspection of Inverter 114 revealed that the master section SCR bank contained SCRs of 1968 and 1969 manufacture and blown fuses in the output stage. Additionally, SCR #1, manufactured in 1969, appears to have been original installation. It's thermal

mounting grease was clearly degraded, particularly at the SCR body to heat sink contact surface. The heat sink surface was also scored, apparently from overtorquing, which would also reduce thermal transfer. In summary, the inspection provided significant evidence in support of the SCR misgate postulation.

Following SCR replacement, three Unit 1 inverters (111, 113, and 114) were found to contain both earlier design SCRs and degraded contact grease. Inverter 112 was believed to have earlier design SCRs but the SCRs were discarded without manufacturer date verification. Thus, the potential for similar failures existed. A review of previous inverter failures was conducted and previously unexplained failures were found to have symptoms consistent with this failure mode.

The cause of the 1D Steam Generator atmospheric relief valve failing to reseat was determined to be the result of a failed valve positioner possibly compounded by a stretched feedback spring.

D. SAFETY ANALYSIS OF EVENT

During this event all safety related equipment operated as designed. Although the 1D atmospheric relief valve failed to reseat, it was quickly identified and isolated by the operators. The steam release resulting from this failure to reseat had minimum effect on Reactor Coolant System temperature. Since the Steam Generator was still protected from overpressurization by the Steam Generator Safety Valves, there was minimal safety significance to this atmospheric isolation.

ZDVRLER-389(4)

TEXT PAGE 4 OF 5

E. CORRECTIVE ACTIONS

1. The following corrective actions were taken for this event:

All Inverter 114 SCRs were replaced prior to unit startup.

All SCRs on the remaining Unit 1 Instrument Inverters (111, 112, and 113) were replaced as a precautionary measure prior to startup.

All transformers were megged, and all fuses and resistors were checked.

All capacitors were checked and found to be operating within acceptable parameters. However, several capacitors in the Master and Slave section of Inverter 114 were replaced as a precaution.

Thermography was conducted and the results of previous thermographies reviewed for the inverter to determine if there were any potential hot spots present. No conclusive problem spots were identified.

Complete visual inspections were conducted and it was determined that there was no physical evidence of damage to any other components in the inverter.

The instrument inverter Preventative Maintenance program was changed, to include lubrication and replacement of the SCRs.

The failed 1D Atmospheric Steam Generator Relief Valve positioner and stretched feedback spring were replaced prior to unit startup.

All required post safety injection walkdowns were completed.

2. The following corrective actions will be taken to minimize the potential for similar events to occur in the future:

As a precaution, all Unit 2 A.C. Instrument Inverter SCRs will be replaced with newer design SCRs during the next Unit 2 refueling outage. (295-180-91-11901)

An engineering evaluation will be performed for possible modification of the Hagan feed flow control output to mitigate the effects on the Lovejoy control unit of a degraded instrument bus voltage condition. (295-180-91-11902)

A review has been performed for potential upgrades of test equipment for the inverter. Procurement for this upgraded equipment is in progress. (295-180-91-11903)

The SCRs that were manufactured prior to 1975 were removed from A.C. Instrument Inverter 114 and will be returned to the manufacturer to determine their gate voltage temperature sensitivity. (295-180-91-11904)

ZDVRLER-389(5)

TEXT PAGE 5 OF 5

F. PREVIOUS EVENTS

SOER 83-3, Inverter Failures, and SER 87-32, Insufficient Ventilation Capacity for D.C. Equipment have been evaluated and their corrective actions would not have mitigated this incident.

LER 22-1-91-050 documents a similar loss of A.C. Instrument Inverter 111 on April 21, 1991. That particular inverter failure is believed to have occurred due to a fault on the load side of the inverter. This belief is based on the short time duration of only .22 seconds for the fault followed by recovery of the breaker. There is no indication that the corrective actions for this previous event would have prevented this inverter failure.

LER 22-1-91-057 documents a similar loss of A.C. Instrument Inverter 112 on May 10, 1991. The cause of that inverter failure was never determined, but SCRs in that inverter were replaced at the time of the inverter failure as a precaution. It is now believed that the A.C. Instrument Inverter 112 failure was caused by the SCRs. A commitment was generated to include SCRs for all instrument inverters in a preventative maintenance program. This program had not yet resulted in SCR replacement prior to this event.

G. COMPONENT FAILURE DATA

MANUFACTURER NOMENCLATURE MODEL

- 1) Westinghouse SCR
- 2) Moore Products Co. Atmospheric Relief Valve 74 Positioner

ZDVRLER-389(6)

ATTACHMENT 1 TO 9112120065 PAGE 1 OF 1

Commonwealth Edison

Zion Generating Station
Shiloh Blvd. & Lake Michigan
Zion, Illinois 60099
Telephone 708 / 746-2084
December 09, 1991

U. S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

Dear Sir:

The enclosed Licensee Event Report number 91-016-00, Docket No. 50-295/DPR-39 from Zion Generating Station is being transmitted to you in accordance with the requirements of 10CFR50.73(a)(2)(iv), which requires a 30 day written report when any event or condition resulted in a manual or automatic actuation of any Engineered Safety Feature (ESF), including the Reactor Protection System.

Very truly yours,

T. P. Joyce
Station Manager
Zion Generating Station

TPJ/dmg

Enclosure: Licensee Event Report

cc: NRC Region III Administrator
NRC Resident Inspector

INPO Record Center
CECo Distribution List

ZDVRLER-389(8)

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